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(54) PURIFYING METHOD OF CARBON NANO-TUBE

(57)Abstract:

PURPOSE: To obtain a high purity carbon nano-tube by adding an acid to a carbon nano-tube, which is produced with a metallic catalyst and contains the metallic catalyst and a metallic carbide as impurities to dissolve the impurities.

CONSTITUTION: The unpurified carbon nano-tube containing the used metallic catalyst and the metallic carbide as the impurities is produced by using a carbon rod as a positive electrode, a mixture of the metallic catalyst (e.g. iron) with carbon as a negative electrode for discharge electrode and a hydrocarbon as a gaseous starting material and applying a method such as arc discharge. Next, the high purity carbon nano-tube is obtained by adding the acid (e.g. nitric acid) to the unpurified carbon nano-tube and preferably heating to dissolve the impurities wherein a method for removing the impurities by pulverizing, dispersing the unpurified carbon nano-tube in a liquid and introducing and passing the liquid through magnetic field can be also used.

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CLAIMS

[Claim(s)]
[Claim 1] The purification approach of the carbon nanotube characterized by dissolving said impurity in the non-refined carbon nanotube which contains as an impurity the carbide of said metal catalyst manufactured using the metal catalyst, and said metal by adding an acid.
[Claim 2] The purification approach of the carbon nanotube characterized by removing said impurity by grinding in a liquid the non-refined carbon nanotube which contains as an impurity the carbide of said metal catalyst manufactured using the metal catalyst, and said metal, distributing, and passing the inside of a magnetic field for said liquid.
[Claim 3] The non-refined carbon nanotube which contains as an impurity carbon matter other than said metal catalyst manufactured using the metal catalyst, the carbide of said metal, and a carbon nanotube Grind and distribute in a liquid and centrifugal separation or flotation removes said carbon matter contained in said liquid. The purification approach of the carbon nanotube characterized by removing said metal impurity by passing the inside of a magnetic field for the liquid after adding an acid to the liquid after removing said carbon matter, and dissolving said metal impurity in it or removing said carbon matter.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the purification approach of a carbon nanotube, and the purification approach of the carbon nanotube especially manufactured using the metal catalyst.
[0002]
[Description of the Prior Art] The usual carbon nanotube with which the above cylindrical graphite layer was partly formed in the shape of a concentric circle had big dispersion in the electrical property and chemistry property of a carbon nanotube uniformly [cylindrical magnitude] therefore. Then, this invention person etc. proposed the manufacture approach of the monoatomic layer carbon nanotube by which the configuration of a tube was controlled by the monolayer on the Japanese-Patent-Application-No. No. 337937 [five to] application specifications. Carbon is used for one side of a discharge electrode, it uses the mixture of a metal (transition metals, such as iron, cobalt, and nickel) and carbon for the electrode of another side, and this monoatomic layer carbon nanotube uses a hydrocarbon for material gas, and is manufactured by arc discharge.
[0003]
[Problem(s) to be Solved by the Invention] However, since the monoatomic layer carbon nanotube obtained by the above-mentioned approach was manufactured using a metal catalyst, it contained carbon matter other than carbon nanotubes, such as a metal catalyst, its carbide and amorphous carbon, and graphite, as an impurity. Therefore, in order to use this carbon nanotube on industry, it is necessary to remove the above-mentioned impurity, and considering the point of the electrical property which a carbon nanotube has, or a chemistry property, it is necessary to remove the carbide of a metal catalyst and its metal also in the above-mentioned impurity especially. However, although the approach flotation and centrifugal separation removed carbon matter other than a carbon nanotube on the conventional technique was shown in JP,6-228824,A, the approach of removing metal impurities, such as carbide of a metal catalyst and its metal, from a non-refined carbon nanotube did not exist until now.
[0004] The purpose of this invention is especially about a metal catalyst and its carbide from the carbon nanotube manufactured using the metal catalyst to also remove carbon matter other than a carbon nanotube further.
[0005]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem, invention of the 1st of this invention is the purification approach of the carbon nanotube characterized by dissolving said impurity in the non-refined carbon nanotube which contains as an impurity the carbide of the metal catalyst manufactured using the metal catalyst, and its metal by adding an acid.
[0006] The 2nd invention is the purification approach of the carbon nanotube characterized by removing said impurity by grinding in a liquid the non-refined carbon nanotube which contains as an impurity the carbide of the metal catalyst manufactured using the metal catalyst, and its metal, distributing, and passing the inside of a magnetic field for said liquid.
[0007] The 3rd invention the non-refined carbon nanotube which contains as an impurity carbon matter

other than the metal catalyst manufactured using the metal catalyst, metaled carbide, and a carbon nanotube Grind and distribute in a liquid and centrifugal separation or flotation removes said carbon matter contained in said liquid. It is the purification approach of the carbon nanotube characterized by removing said metal impurity by passing the inside of a magnetic field for the liquid after adding an acid to the liquid after removing the carbon matter, and dissolving said metal impurity in it or removing the carbon matter.

[0008]

[Function] The purification approach of the carbon nanotube of this invention grinds and stirs a rough product, removes carbon matter other than carbon nanotubes, such as amorphous carbon and graphite, with centrifugal separation and flotation, adds an acid further, melts a metal, or by passing the inside of a magnetic field, removes a metal impurity and raises the purity of a carbon nanotube.

[0009]

[Example] One example of this invention is shown below.

[0010] (Example 1) Using the carbon rod with which the carbon rod was included in one electrode (positive electrode) of a discharge electrode, and it included the metal (transition metals, such as iron, cobalt, and nickel) in the electrode (negative electrode) of another side, in the mixed-gas ambient atmosphere of methane, hydrogen, and helium, the rough product of the monoatomic layer carbon nanotube used for purification was manufactured by arc discharge, and was obtained. It is usable, and since the surface ratio of the carbon exposed to a carbon rod front face and a metal is controllable also by temperature at which an electrode melts into it when what made the hole in the carbon rod and inserted metal wires (low carbon steel wire etc.) in it is used for the negative electrode at this time and this uses a metal rod for it as the negative electrode with the number of the metal wire to insert, metaled evaporation is controllable by it. In this example, the size obtained a lot of monolayer carbon nanotubes to which it was equal in 1-2nm by carrying out arc discharge by discharge voltage 30V and discharge current 50A in the ambient atmosphere of methane 20Torr, gaseous helium 180Torr, and hydrogen gas 10Torr, using the carbon rod with which the low carbon steel wire was inserted as the negative electrode.

[0011] The monolayer carbon nanotube rough product obtained by the above-mentioned approach contains as an impurity carbon matter other than carbon nanotubes, such as carbide of the metal catalyst used at the time of manufacture, and its metal and amorphous carbon, and graphite. Then, the rough product obtained by the above-mentioned approach was put into the steel ball and the container into which ethanol was put, and the shaker (for example, a supersonic wave is applied) ground it, and it was stirred in liquid. Minute spherical particles, such as amorphous carbon and graphite, were removed by covering this solution over a centrifugal separation machine, and removing a supernatant. Furthermore, by adding a nitric acid to the sample which removed this supernatant, iron was melted and the monoatomic layer carbon nanotube was refined. Thereby, carbon matter other than a carbon nanotube was [a metal catalyst and its carbide] also further removable from the carbon nanotube manufactured using the metal catalyst. It is more desirable to be able to use a hydrochloric acid etc. other than a nitric acid, and to add and warm an acid as an acid. The temperature in this case should just be below temperature (about 100 degrees C) that an acid does not boil.

[0012] (Example 2) The same purification as an example 1 was performed until it removed the supernatant. Then, in this example, by passing the inside of a magnetic field for the solution which removed the supernatant, iron was removed and the monoatomic layer carbon nanotube was refined. A metal catalyst, its carbide, and carbon matter other than a carbon nanotube were removable from the carbon nanotube manufactured also by the approach of this example using the metal catalyst.

[0013]

[Effect of the Invention] According to this invention, carbon matter, such as amorphous carbon and graphite, is [the metal catalyst or its carbide in the carbon nanotube manufactured using the metal catalyst] also further removable. Thereby, the configuration of a tube is controlled by the monolayer and a carbon nanotube with high purity is obtained.

[Translation done.]